

Association between suppression of otoacoustic emissions and annoyance levels in tinnitus patients with normal hearing

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ABSTRACT

Objective: To correlate the annoyance of tinnitus assessed by the Tinnitus Handicap Inventory and on a visual analogue scale with the suppression of otoacoustic emission test in tinnitus patients with normal hearing.

Study design: Case-control study. **Setting:** Public tertiary hospital.

Subjects and methods: The sample was initially based on a population of 80 subjects with tinnitus; 20 of them had normal hearing and normal evoked otoacoustic emission test results and comprised the study group. For the purpose of comparison, a control group was formed, which consisted of 17 subjects with no hearing complaints and normal hearing. The participants were submitted to hearing tests, immittance testing and tests for the evaluation of acoustic reflexes, distortion product otoacoustic emissions, transient evoked otoacoustic emissions (TEOAEs), and suppression of TEOAEs. The tests were performed in a sound-treated booth using a linear contralateral noise of 60 dB. The presence of suppression effects was defined when the response amplitude was 0.5 dB or higher.

Results: Abnormal evoked otoacoustic emission suppression test results were observed in 52.9% of tinnitus patients and in 32.4% of control subjects ($p = 0.086$). Suppression effects of TEOAEs were absent in 38.5% of subjects with minimal or mild discomfort and in 61.9% of subjects with moderate or severe discomfort ($p = 0.183$).

Conclusion: It was not possible to associate the annoyance caused by tinnitus with the TEOAE suppression test results, although suppression effects were found to decrease with increasing annoyance.

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INTRODUCTION

Tinnitus is a sound perceived in one or both ears even in the absence of a sound stimulus, which directly affects the quality of life of individuals.¹⁻³

The annoyance caused by tinnitus has negative impacts on the life of affected individuals, reducing concentration and sleep and compromising emotional balance and social life. About 20% of patients with tinnitus report significant annoyance associated with major impairment of quality of life.⁴⁻⁶

Several lines of research have been proposed to better understand the auditory pathway in tinnitus patients with normal hearing. One of these lines advocates that changes at central levels of the auditory system and in the efferent pathway, more specifically in the superior olivary complex, are one of the causes of tinnitus in normal-hearing individuals, although the role of the efferent system in the etiology of tinnitus remains unclear.⁶⁻⁸

The otoacoustic emission (OAE) Suppression may be absent in cases of tinnitus, but its association with possible dysfunction in the medial efferent tract has not been confirmed.

There are no studies in the literature establishing a correlation between the level of annoyance reported by tinnitus patients and the OAE suppression test. Therefore, the aim of the present study was to investigate the occurrence of this association.

METHODS AND MATERIALS

This case-control study was approved by the institutional Research Ethics Committee (Protocol No. 453.379).

20 subjects with normal hearing determined by a hearing test and normal results for distortion product otoacoustic emissions (DPOAEs) and transient evoked otoacoustic emissions (TEOAEs) were included in the study (tinnitus group). A control group was formed, which consisted of 17 subjects of both genders with confirmed presence of OAEs and no tinnitus complaints. They were also submitted to the following assessments: anamnesis and evaluation of tinnitus annoyance by the Tinnitus Handicap Inventory (THI) and on a Visual Analog Scale (VAS).

Patients with normal OAE test results were submitted to OAE suppression testing. For analysis of the suppression effect, an linear click presented at an intensity of 65 dB NPS was used as the evoking stimulus. The suppressor noise consisted of contralateral white noise stimulation at intensity of 60 dB NPS.

The data were analyzed and correlated using the SPSS 21.0 for Windows software. The following analyses were performed: comparison of DPOAEs and TEOAEs and of the suppression effect of TEOAEs between the tinnitus and control groups; analysis of tinnitus annoyance and comparison with the TEOAE suppression test result, and trend analysis (ANOVA). A level of significance of $\leq 5\%$ ($p \leq 0.05$) was adopted.

RESULTS

TEOAE analysis showed higher amplitudes (S/R) in the control group compared to tinnitus group at all frequency bands tested.

No significant differences in the overall suppression effect or in the values according to frequency band were observed between the two groups.

Regarding the discomfort caused by tinnitus and assessed by the THI, 38.2% ($n=13$) of the participants were classified as having minimal or mild tinnitus and 61.8% ($n=21$) as having moderate or severe tinnitus. There was no case of catastrophic tinnitus. Analysis of the discomfort caused by tinnitus on a VAS showed mild discomfort in 8.8% ($n=3$) of the subjects, moderate discomfort in 41.2% ($n=14$), and severe discomfort in 50% ($n=17$).

The correlation between the discomfort caused by tinnitus and the level of TEOAE suppression was also analyzed. Among subjects who reported minimal/mild discomfort, 38.5% ($n=5$) exhibited no suppression effect of TEOAEs. Among subjects with mild/severe tinnitus, 61.9% ($n=13$) exhibited no suppression effect of TEOAEs. The difference between these two groups was not statistically significant.

Although no significant correlation was found between the discomfort caused by tinnitus and OAE suppression effects, the results were analyzed using tests for homogeneity of variances and trends. As can be seen in Figure 1, the absolute values of the suppression effect decreased with increasing discomfort caused by tinnitus.

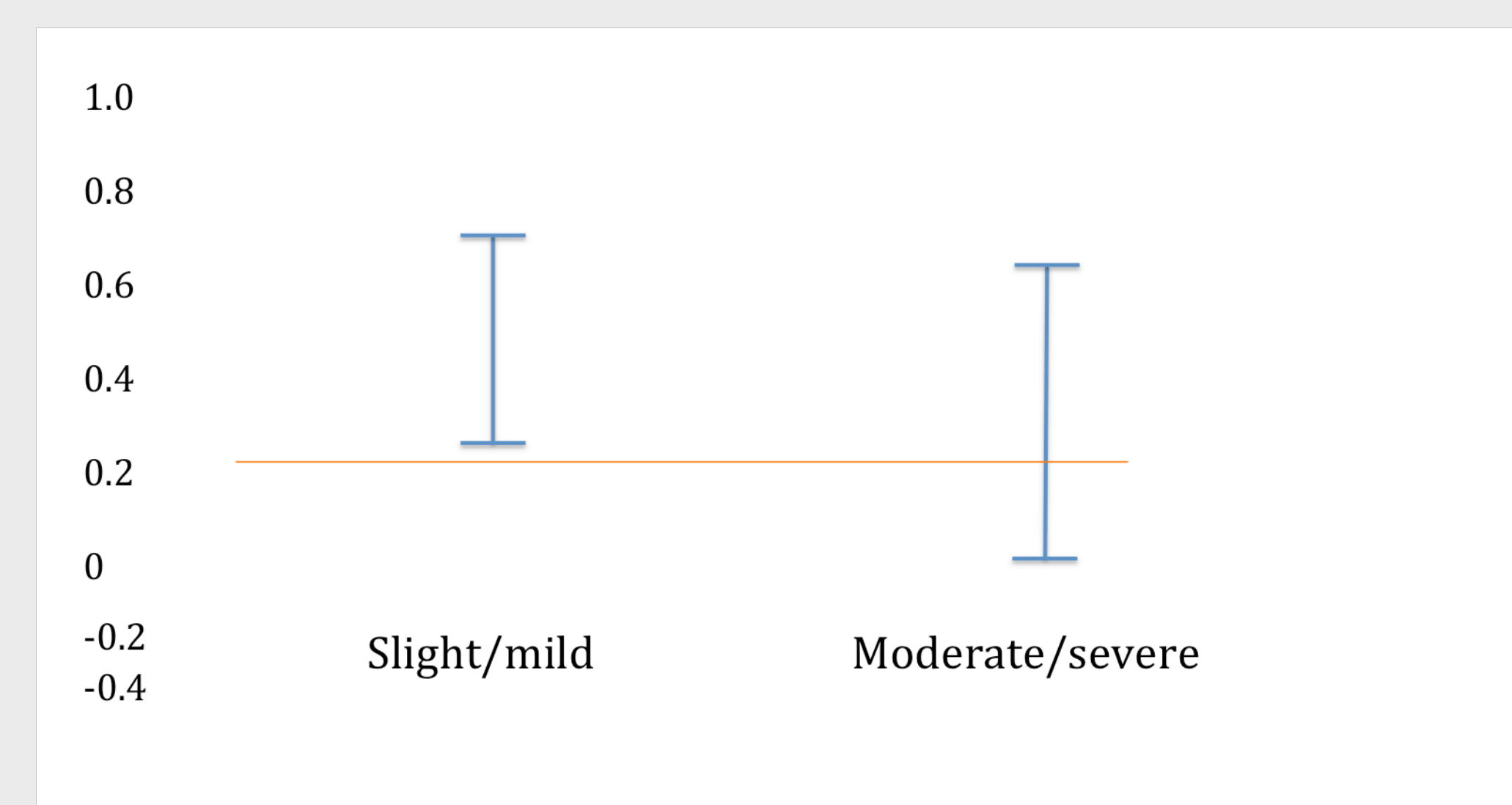


Figure 1. Trends of suppression effects according to tinnitus intensity assessed by the Tinnitus Handicap Inventory in subjects of the tinnitus group (ANOVA for trend analysis).

Overall suppression effect		Annoyance assessed by THI				P
		Slight/mild	Moderate/severe	Catastrophic	Total	
Absent	n	5	13	0	18	0.183
	%	38.5%	61.9%	0%	52,9%	
Present	n	8	8	0	16	
	%	61.5%	38.1%	0%	47,1%	
Total	n	13	21	0	34	
	%	100%	100%	0%	100%	

Table 2 – Association between the suppression effect of transient evoked otoacoustic emissions and tinnitus annoyance assessed by the Tinnitus Handicap Inventory in subjects of the tinnitus group.

DISCUSSION

Alterations in OAEs are more common in individuals with tinnitus compared to those without the symptom. Granjeiro⁹, studying a group of subjects with tinnitus and normal hearing, observed altered TEOAEs and DPOAEs in 61.8% of this group, while this percentage was 23.9% in the control group. In a similar study, Paglialonga *et al*¹⁰ found altered DPOAE tests in 78% of subjects with tinnitus. The authors emphasized that DPOAEs were more sensitive in detecting outer hair cell dysfunction in individuals with tinnitus than TEOAEs.

The participants in the present study exhibited no changes in the DPOAE and TEOAE tests according to the protocol established in the methods section. Thus, the cochlear mechanism was completely or partly intact in this population.

Although the presence of normal OAEs was used as an inclusion criterion in the present study, the OAE response amplitudes were lower in tinnitus patients than in the control group; however, this difference was not statistically significant in the DPOAE or TEOAE test.

Tinnitus patients exhibited a lower overall suppression effect and suppression according to frequency than control subjects. However, the difference between the overall results showed no significant association. The value of OAE suppression tended to decrease as the level of annoyance caused by tinnitus increased. This finding provides further evidence of involvement of the efferent system in the generation of tinnitus.

CONCLUSIONS

The present study suggest that the annoyance caused by tinnitus is not associated with outer hair cell function, and also does not seem to be related to dysfunction of the medial efferent system.

Suppression effects were absent in a considerable proportion of the tinnitus patients studied. However, this finding was also common in control subjects, with no significant difference between groups. The OAE suppression test only evaluates a small part of the efferent system, i.e., the medial olivocochlear system. The present study suggests that, although dysfunction of the medial efferent system is one of the theories accepted as an etiology of tinnitus, the changes found in this system do not seem to be related to the annoyance reported by the patients of this study.

REFERENCES

- The Royal National Institute For Deaf People. Available at: http://www.rnid.org.uk/information_resources/. Accessed October 10, 2013.
- Esteves CC, Brandão FN, Siqueira CGA, Carvalho SAS. Audição, zumbido e qualidade de vida: um estudo piloto. Rev Cefac. 2012, set-out;14(5):836-43.
- Baguley D, McFerran D, Hall D. Tinnitus. The Lancet. Publicada online(2/72013) DOI: [http:// dx.doi.org/10.1016/S0140-6736\(13\)60142-7](http://dx.doi.org/10.1016/S0140-6736(13)60142-7).
- Riga M, Papadas T, Werner JA, Dalchow C. A clinical study of the efferent auditory system in patients with normal hearing who have acute tinnitus. OtolaryngolNeurology. 2007, fev;28(2):185-90.
- Lewis JE. Tinnitus and suicide. J Am Acad Audiol. 2002. Jun;13(6):339-41.
- Kehrle HM, Granjeiro RC, Sampaio ALL, Bezerra R, Almeida V.F, Oliveira CA. Comparison of auditory brainstem response results in normal-hearing patients with and without tinnitus. Arch Otolaryngol Head Neck Surg. 2008, 134(6): 647-51.
- Savastano M. Tinnitus with or without hearing loss: are its characteristics different? European Archives of Oto-Rhino-Laryngology. 2008, 265 (11): 1295-1300.
- Mor R; Azevedo MF. Emissões otoacústicas e sistema olivococlear medial: paciente com zumbido e sem perda auditiva. Pró fono, 2005, set-dez; 17(3): 283-92.
- Granjeiro RC, Kehrle HM, Oliveira TSC, Sampaio AL, Oliveira CA. Is the degree of discomfort caused by tinnitus in normal-hearing individuals correlated with psychiatric disorders? Otolaryngol Head Neck Surg. 2013; 148(4): 658-63.
- Paglialonga, A.; Del Bo, L.; Ravazzani, p.; tognola, g. Quantitative analysis of cochlear active mechanisms in tinnitus subjects with normal hearing sensitivity: multiparametric recording of evoked otoacoustic emissions and contralateral suppression. Auris Nasus Larynx. 2010. Jun 37(3): 291-8.